Entity-Based Modeling:
The Department Head Tour Length Problem for SWOs

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SWO Career Path Model

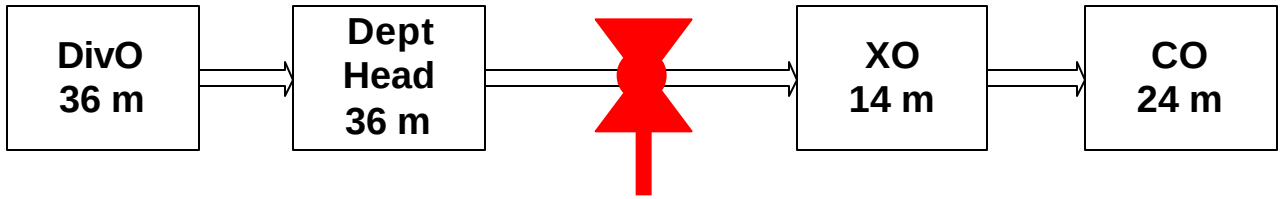
"Develop a model to solve a particular problem, not to model the system."

John Sterman

- Our goals had wider model boundaries than for a single, specific question
- Ideally, generic tool for many questions

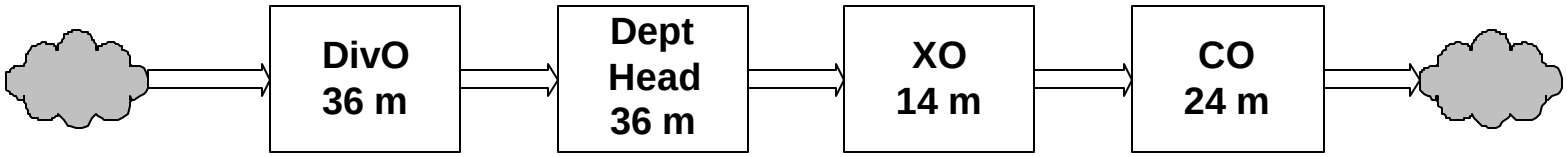
SWO DH Tour Lengths

- DH tour lengths are adjusted based on inventory to maintain selectivity



- Cannot reasonably solve the problem in a single step
- DHs may have different tour lengths based on when they arrived

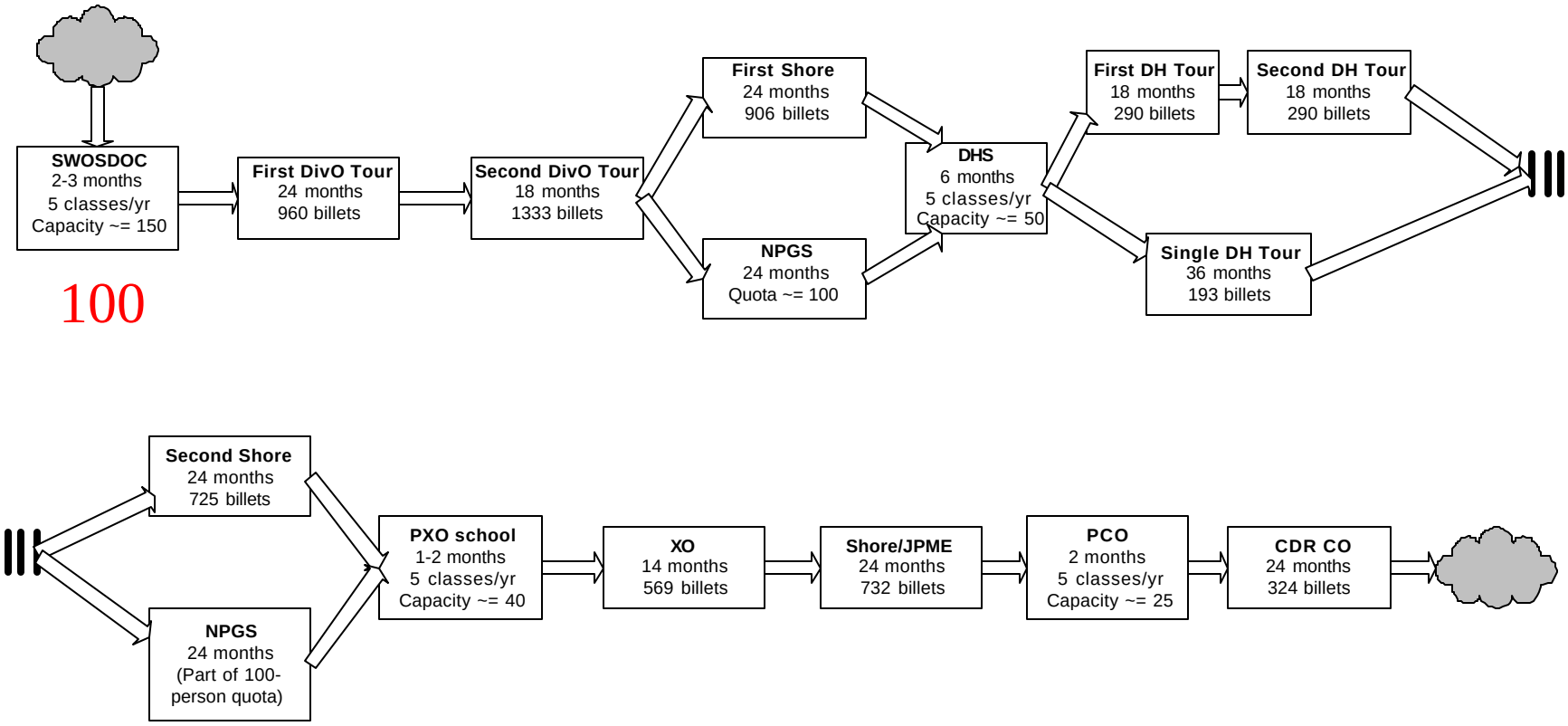
Approach: Stock and Flow



- **Stocks** have a number that represents how many “things” are in them
- **Flows** govern how many “things” transition between the stocks
- System Dynamics, Continuous Simulation
- Discrete event

Typical Stock-and-Flow

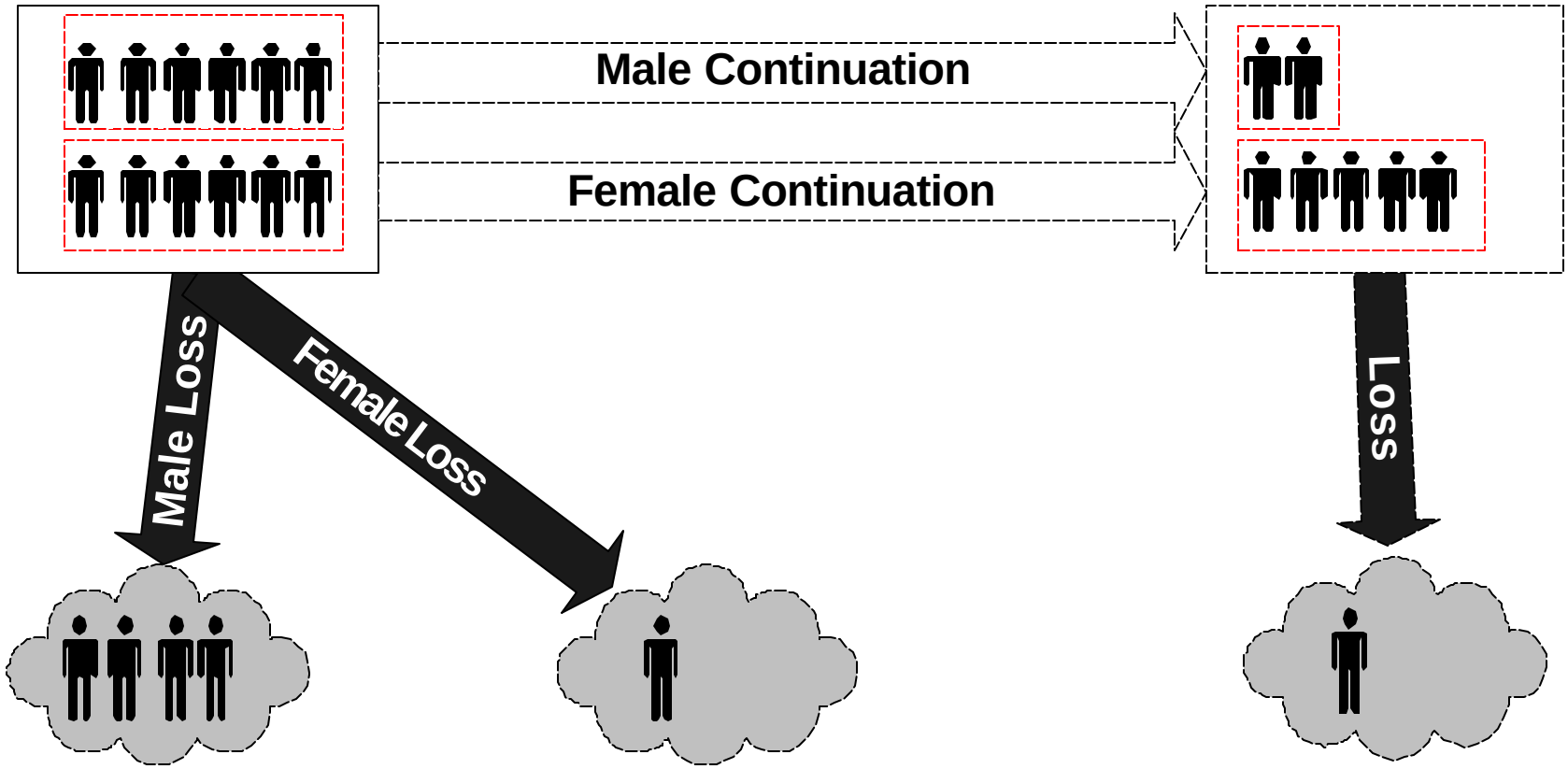
Numbers flow through stocks



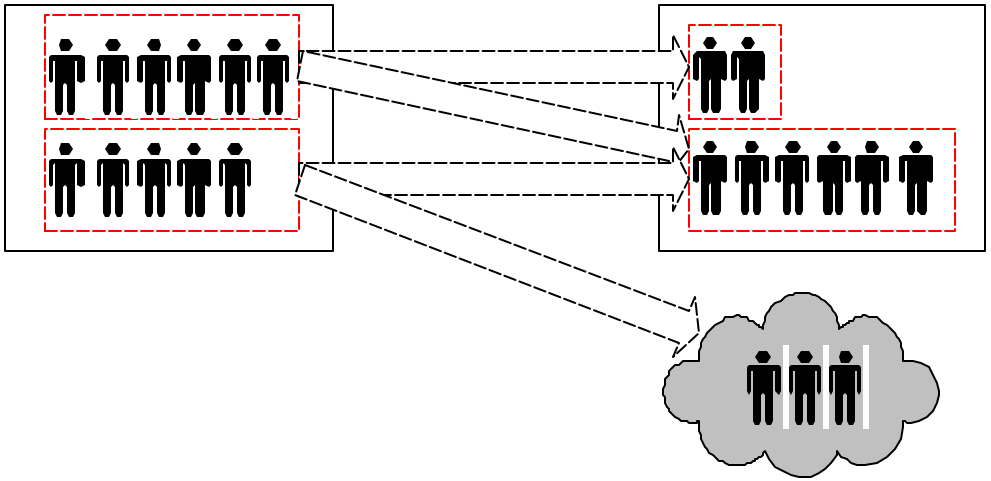
Attribute Explosion Problem

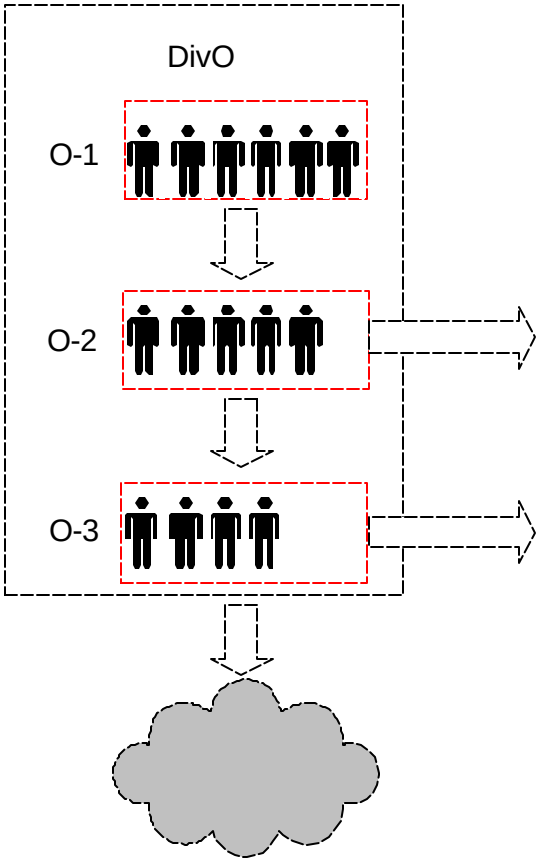
Attributes	Combinations
Typical Stock	1
Gender	2
Gender + Screened	4
Rank	6
Gender + Screened + Rank	24
Year group	22
Gender + Screened + Rank + YG	528

Discrete Event with Attributes

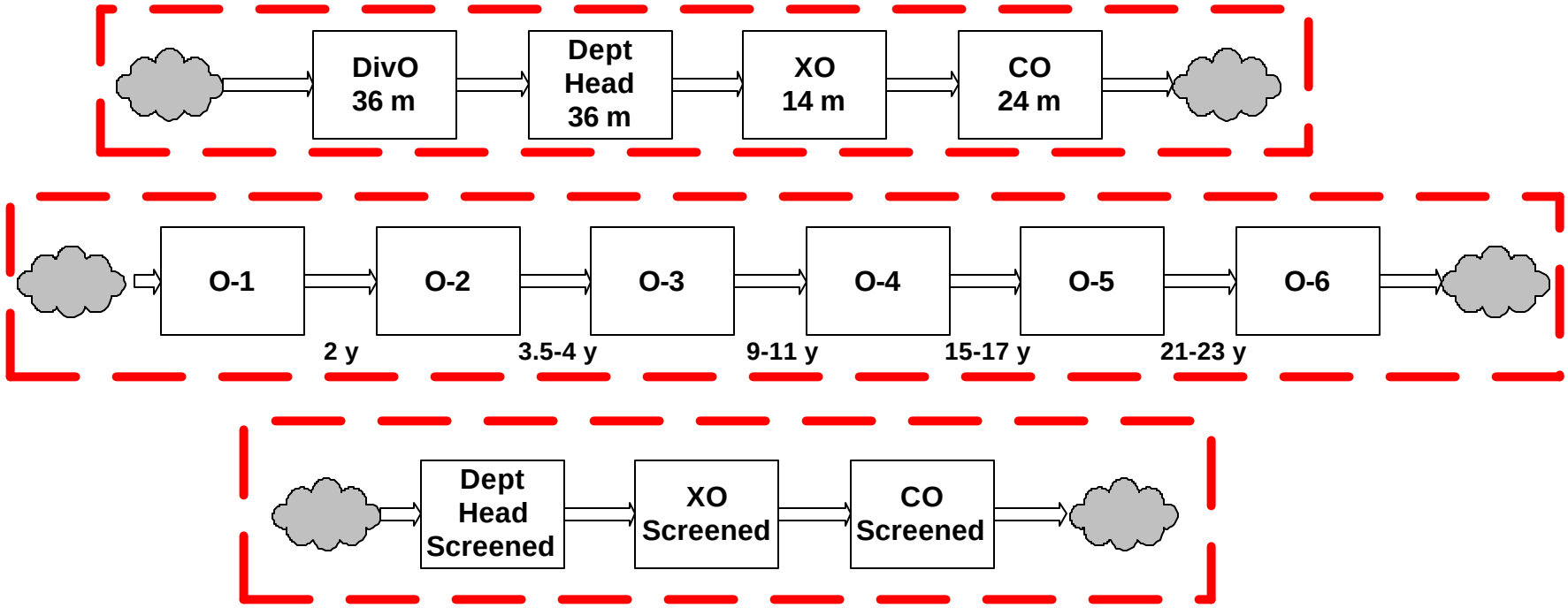


Attributes Change on Flows





Multiple Paths Simultaneously

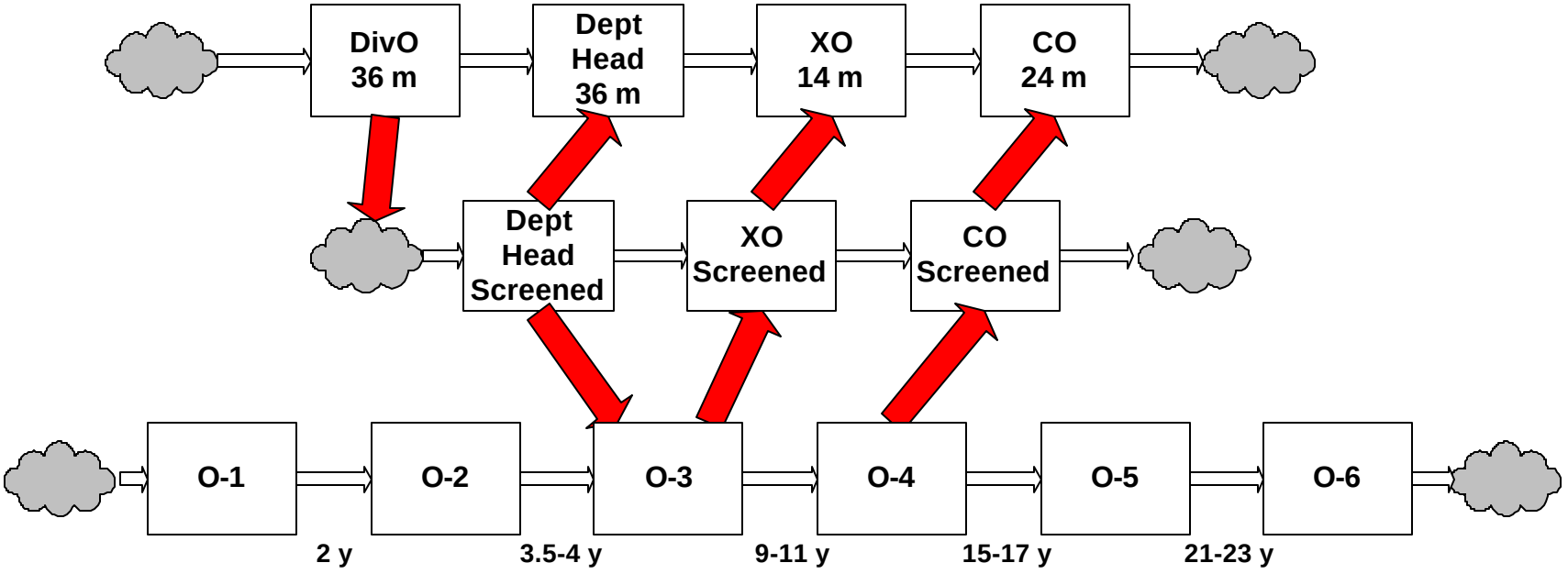


"…it is difficult for time-dependent operations to be intertwined with the tour flows."

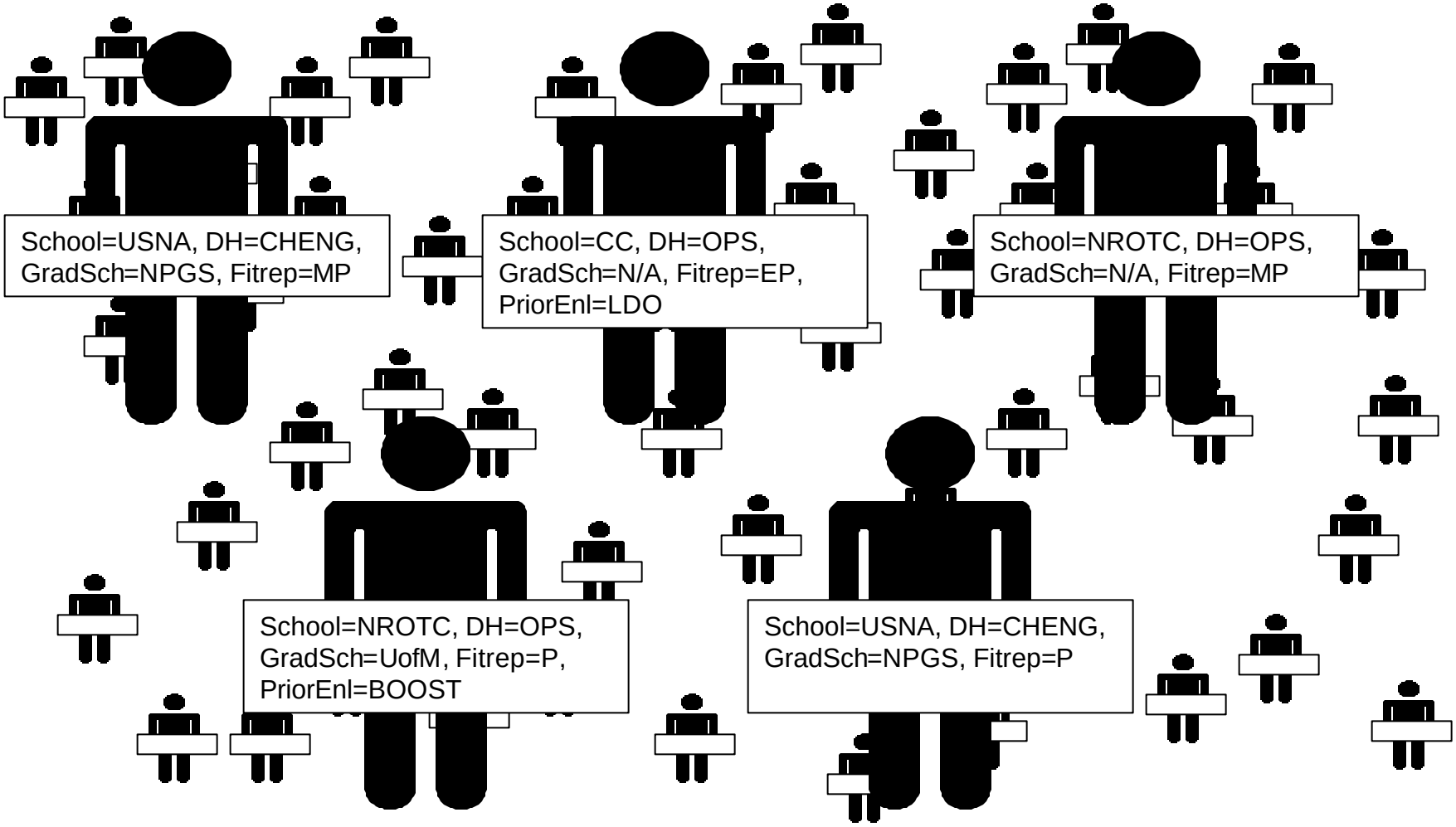
David Rodney
CRM 92-81

Paths are Dependent

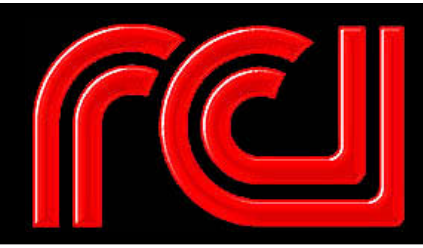
In fact, the real-world business rules are not simply time dependent; there are interdependencies between the models.



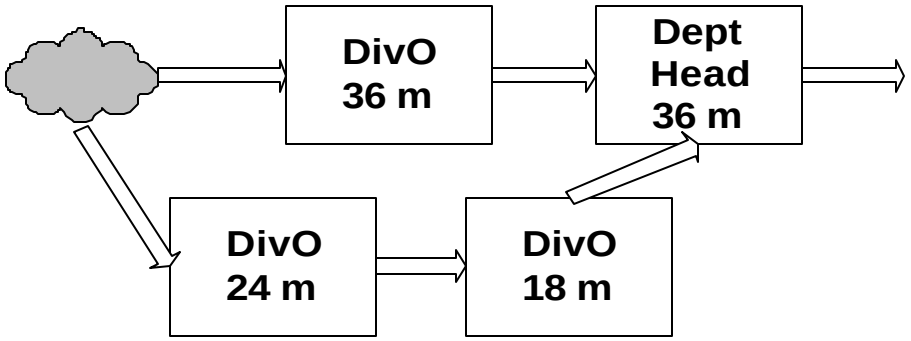
Solution (Pt 1): Entity-Based Models



State/Behavior in Stock-and-Flow



- State and behavior are tightly coupled
- Cumbersome:
  - People cannot be in two places at once
  - State can be lost once paths merge



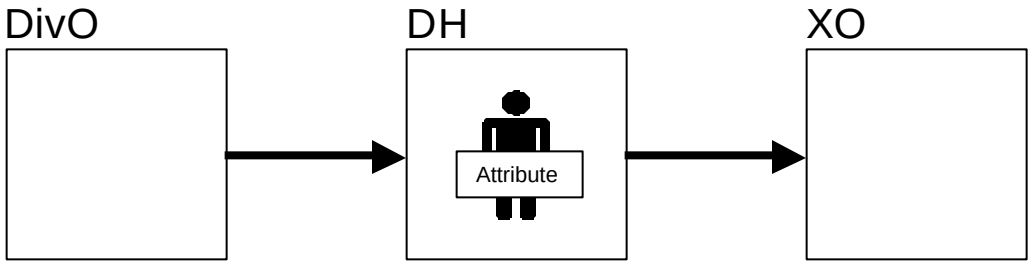
State/Behavior in Entity-Based

- State: **Entities** and their **Attributes**
  - Entities are individual people
  - Attributes are generic attribute/value pairs
- Behaviors: **Business Rules**

  Generic rules, based on core processes
  - Distribution (Moving people)
  - Selection (Changing people)

Solution (Pt 2): Process Flow

Entities don’t flow, processes flow around them



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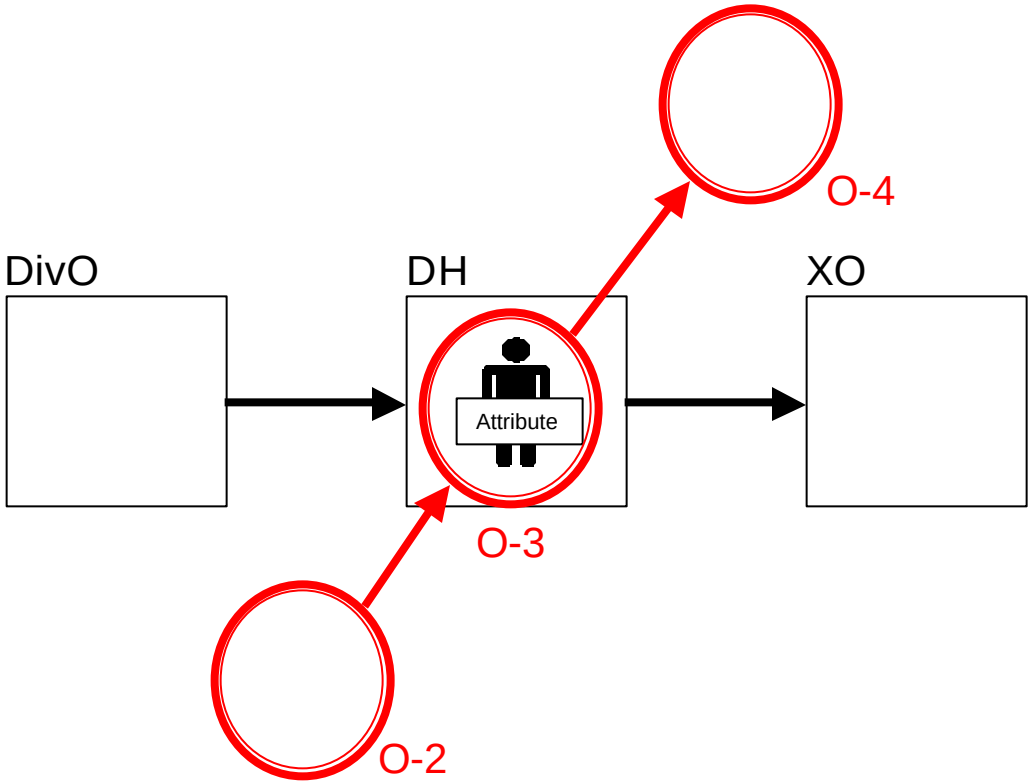

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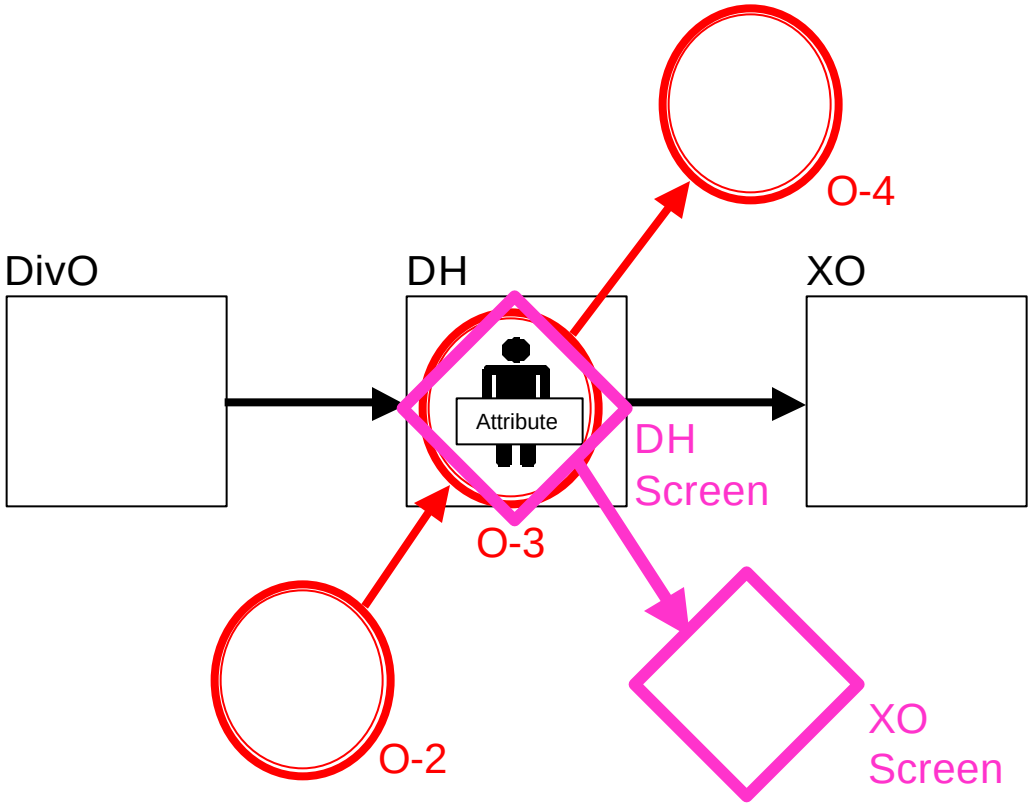
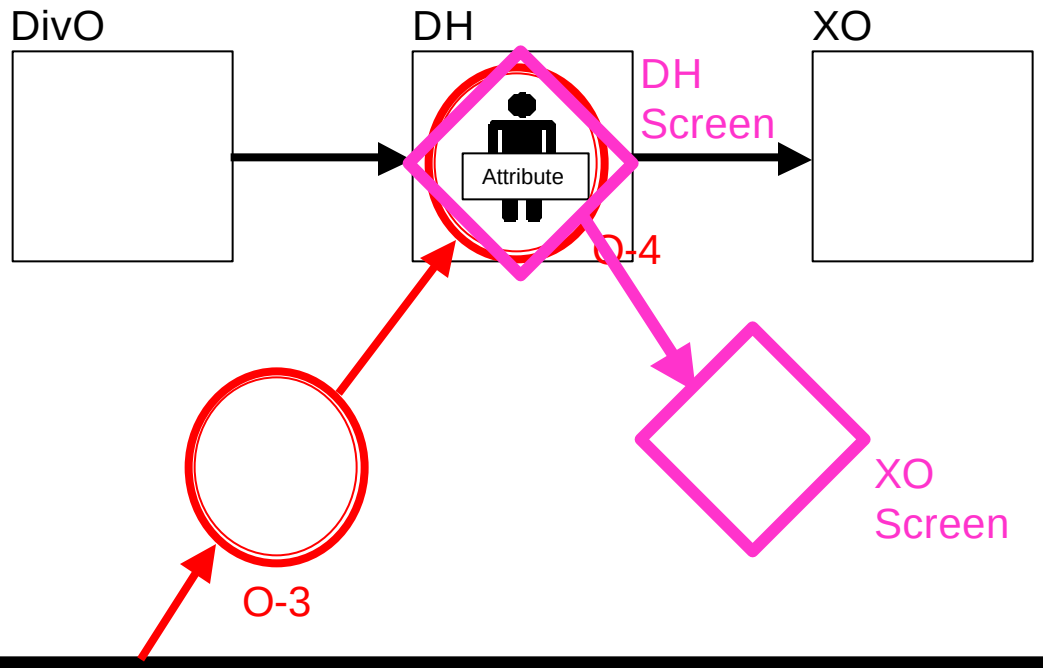


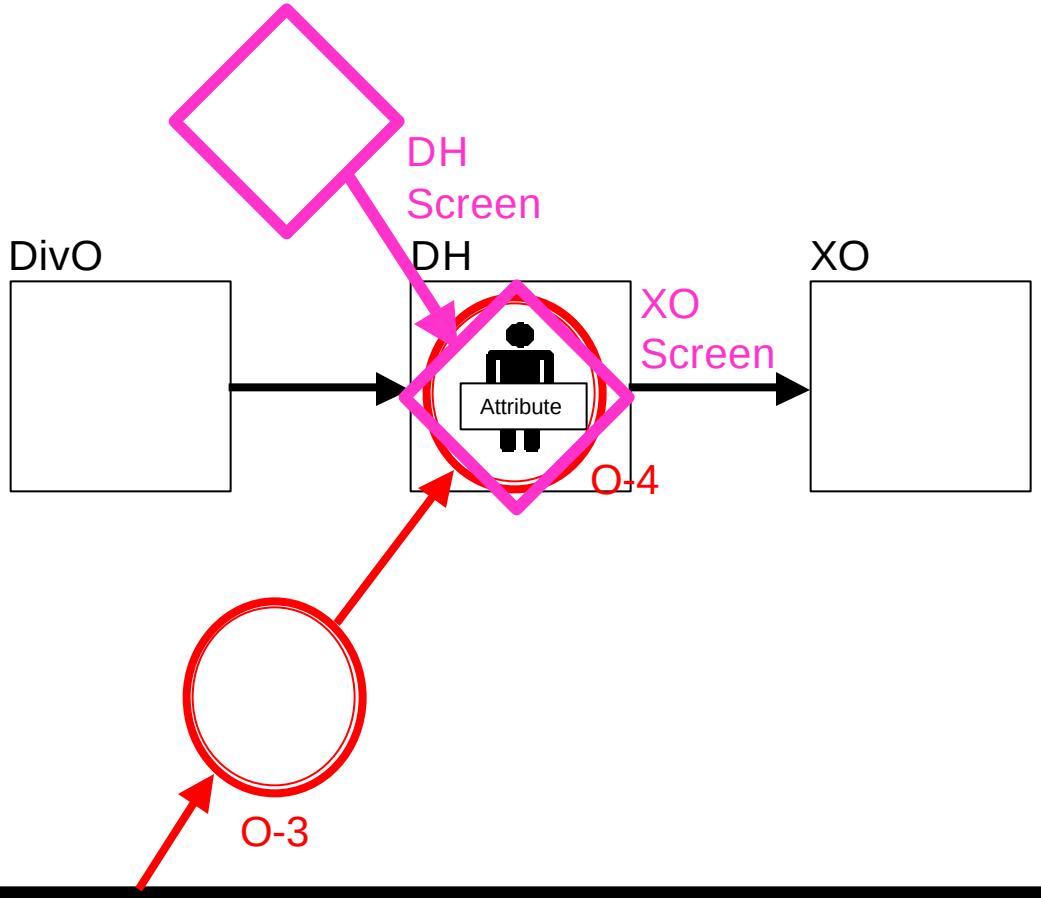
Process Flow 2

Promotion



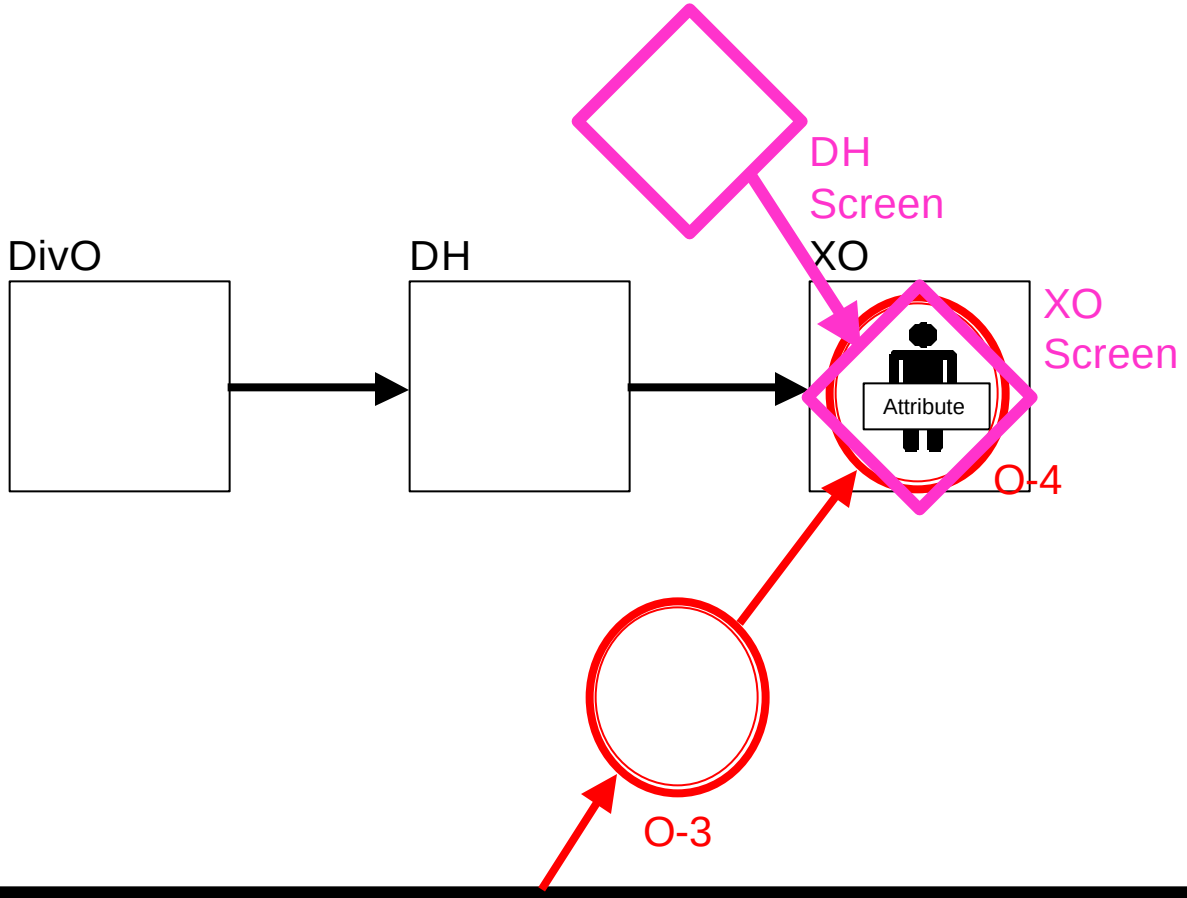
Process Flow 3

Selection

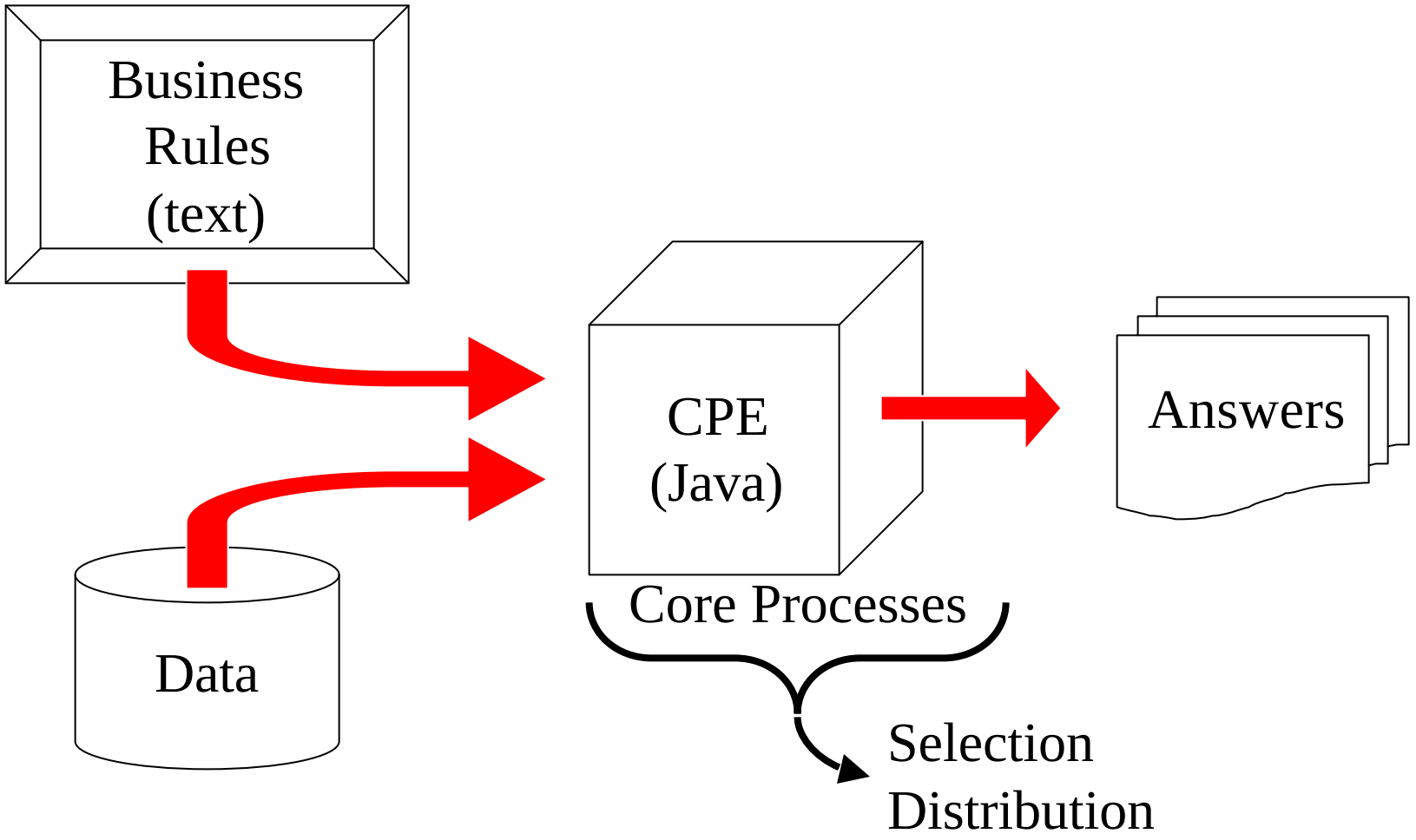


Process Flow 4

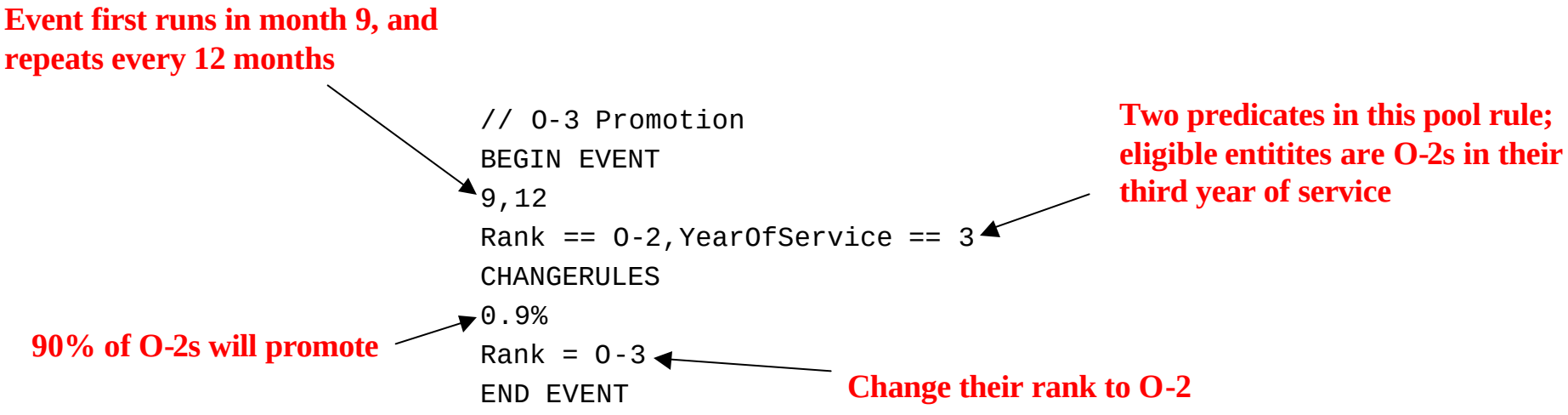
Rotation



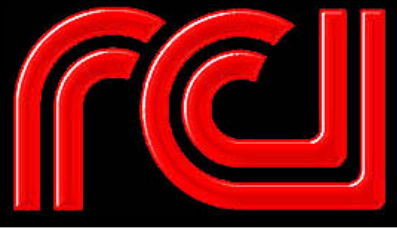
Career Path Engine



Sample Rule


Event first runs in month 9, and repeats every 12 months
// O-3 Promotion
BEGIN EVENT
9,12
Rank == O-2,YearOfService == 3
CHANGERULES
0.9%
Rank = O-3
END EVENT
Two predicates in this pool rule; eligible entitites are O-2s in their third year of service
90% of O-2s will promote
Change their rank to O-2

Benefits



- “Intertwining” is easier
- Processes can share data
- Encapsulation of business rules; can add/remove/modify a “process chain” without fundamentally changing the others
- Scalability
  - Enlarge model boundaries
  - No attribute explosion
  - Develop more holistic understanding of domain
  - Parallelizable or distributable

Time Variations

- Model can change over time
- For example: DH tour length as an attribute
- Can stop and modify
- Can record and roll-back